DETONATOR ASSEMBLY

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to a detonator assembly and is also concerned with a method of installing a plurality of detonators in a plurality of respective boreholes.

[0002] It is known to make use of electronic detonators, which are individually programmable, to establish a blasting configuration. Each detonator is assigned a unique identity number and is connected in parallel to a trunk cable. As each detonator is uniquely identified it is possible to address a chosen detonator and program desired blasting information into the detonator.

[0003] In a different connection technique a plurality of detonators are connected to one another in a daisy-chain configuration. In this arrangement the detonators are addressed in sequence with a given detonator being placed in a programming mode while the other detonators are in a non-programmable mode. Certain benefits are associated with a daisy-chain arrangement although one disadvantage arises from the need to make a connection between each detonator in the sequence and the following and preceding detonators. This aspect and the capability of being able to insert a detonator to a variable depth inside a borehole, give rise to a requirement that two variable lengths of cable must be associated with each detonator viz. a first cable length to go down a first borehole and a second cable length to go from the first borehole to an adjacent, second borehole. In dealing with the cables associated with each of a large number of detonators, the cables can become entangled with one another and errors can arise in configuring a blasting sequence.

[0004] Another aspect which should be addressed is that each detonator should be packaged in a way which facilitates the use of automated manufacturing and testing processes, which readily allows for handling and transport, and which enables each detonator to be labelled so that it complies with applicable regulations and legislation.

SUMMARY OF INVENTION

[0005] The invention provides a detonator assembly which includes a first cable coil with first and second ends, a second cable coil with third and fourth ends, a detonator connected to the first end of the first cable coil, a first connector connected to the second end of the first cable coil and to the third end of the second cable coil, and a second connector connected to the fourth end of the second cable coil and wherein a first variable length of cable, extending from the first end, can be drawn from the first cable coil without materially moving the first connector and a second variable length of cable, extending from the fourth end, can be drawn from the second cable coil without materially moving the first connector.

[0006] The first cable coil may be provided in the form of a first tubular roll. The first end may be inside the first tubular roll. Similarly the second cable coil may be provided in the form of a second tubular roll and the fourth end may be inside the second tubular roll.

[0007] The detonator assembly may include a confinement structure of any appropriate type for maintaining the cable in the required coiled configuration.

[0008] The first connector may be accessible without opening or removing the confinement structure. The first connector may for example be positioned on an outer side of the confinement structure.

[0009] The second and third ends of the cables, which are connected to the first connector, are preferably integrally connected and at no time are separable from each other. These ends may extend out of the confinement structure.

[0010] The confinement structure may be in the form of a housing which includes a first compartment for the first cable coil. A second compartment may be provided inside the housing for the second cable coil. At least one divider may be positioned between the compartments. Preferably the first and second cable coils are separated by at least two dividers. Each divider may be provided in any appropriate way and preferably each divider abuts at least one recessed formation which extends from an outer surface of the housing into an interior of the housing.

[0011] The confinement structure may be circular cylindrical or in the form of a parallelepiped. In one embodiment the confinement structure is in the form of a housing which is made from a relatively rigid material, and the housing has four relative large sides and two relatively small sides which form opposed ends of the housing.

[0012] The housing may be made from any suitable material and maybe made from a rigid material such as cardboard which may be corrugated or a similar bio-degradable material.

[0013] The first and third ends of the cables may extend through respective apertures in the smaller sides of the housing.

[0014] In a preferred form of the invention the confinement structure is made from flexible sheet material. The sheet material may extend around the cable coils and may have a composition which allows the sheet material to be shrunk onto the coils. This type of sheet material is known in the art.

[0015] Each cable coil may be positioned inside a respective enclosure which, in turn, is located inside the confinement structure. The enclosure may comprise flexible sheet material such as plastic film. Each cable coil may comprise a plurality of windings arranged in overlying layers around a hollow core.

[0016] The windings may be arranged so that they form a circular cylindrical shape. The first end may extend from an innermost winding of the first cable coil, facing the respective hollow core. This allows the cable to be withdrawn from the first cable coil without removing the first coil from the confinement structure.

[0017] The fourth end may be similarly configured with respect to the second cable coil.

[0018] The invention also provides a method of forming a cable coil assembly which includes the steps of drawing cable from a supply source and winding a single coil of a first predetermined length around a first former, severing the cable so that the single coil is separated at a first end from the supply source, and forming a first cable coil by winding cable, of a second predetermined length which is shorter than the first length, drawn from the single coil, commencing at the first end, around a second

former, and thereby simultaneously forming a second cable coil of a length which is substantially equal to the difference between the first and second lengths.

[0019] The single coil may be formed by winding the cable in a first direction around the first former and the first coil may be formed by winding cable drawn from the single coil in a second direction around the second former, wherein the first direction is opposite to the second direction.

[0020] The first cable coil may be positioned so that it is co-axial with the second cable coil.

[0021] The invention also provides a method of installing a plurality of detonators in a respective plurality of boreholes in a daisy-chain configuration which includes the steps, for each borehole, of drawing a first length of cable from a first cable coil in confinement structure, positioning a first detonator which is connected to a first end of the first length of cable at a predetermined depth inside the respective borehole, drawing a second length of cable from a second cable coil inside the confinement structure and connecting a first connector which is at a junction of the first and second coils, at the confinement structure, to a second connector which is at an end of a respective second length of cable associated with a first borehole.

[0022] The method may include the step of connecting a respective second connector at an end of the second length of cable, associated with the respective borehole, to a respective first connector at a second borehole.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The invention is further described by way of examples with reference to the accompanying drawings in which:

Figure 1 schematically depicts a plurality of detonators which are located in respective boreholes and which are connected to each other in a daisy-chain configuration;

Figure 2 is a cross sectional view of a detonator assembly according to the invention;

Figures 3 and 4 are perspective views of the detonator assembly of Figure 2 illustrating different aspects thereof;

Figure 5 is a schematic side view of a detonator assembly according to the invention with a housing thereof fully opened;

Figures 6 to 8 show the detonator assembly in different stages of manufacture;

Figures 9, 10 and 11 illustrate steps in the winding of cable coils for use in a detonator assembly according to one form of the invention;

Figure 12 is a perspective view of a detonator assembly according to a variation of the invention;

Figure 13 is a side view in cross section of the detonator assembly in Figure 12; and

Figure 14 is similar to Figure 1, depicting the use of a plurality of the detonator assemblies in Figure 12, in a blasting system.

DESCRIPTION OF PREFERRED EMBODIMENT

[0024] Figure 1 of the accompanying drawings illustrates schematically a plurality of boreholes 10A, 10B ... 10N which are drilled in the ground 12 using conventional techniques. A respective detonator 14A, 14B ... 14N is placed in each borehole. A first length 16A, 16B ... 16N of cable extends from the respective detonator to a respective first connector 18A, 18B ... 18N which is positioned at surface, and a

respective second length 20A, 20B .... 20N of cable extends between adjacent pairs of connectors 18A and 18B, 18B and 18C, ... 18N – 1 and 18N.

[0025] As indicated in the preamble to this specification practical problems arise, when making a daisy-chain arrangement of the type shown in Figure 1, in that the lengths 16 and 20 of the cables are variable. If standard lengths of cable are connected, beforehand, to a connector 18 then once a detonator 14 is placed in a borehole a first excess portion of cable can lie at the mouth of the borehole while, once a connection is made between a connector 18A and a following connector 18B, a second excess length of cable can lie on the surface between the boreholes. The invention is aimed at addressing at least this type of problem.

[0026] Figure 2 illustrates a detonator assembly 30 according to the invention. The assembly includes a cable confinement structure which is formed by a housing 32 which is of parallelepiped form which, as is more clearly shown in Figures 3 and 4, has four relatively large rectangular sides and opposed ends 34 and 36 which are smaller than the larger rectangular sides. The housing 32 is made from a corrugated cardboard blank 38 generally of the type shown in Figure 5 which is formed with lines of weakness and cut-outs so that the blank can be folded into the configuration shown in Figures 3 and 4. At three of its longitudinal corners 40A, 40B and 40C respectively, portions of the blank can be forced inwardly to form right angled recess formations 42A, 42B and 42C respectively. As is shown in Figure 2 end portions 44 and 46 of the blank abut these formations, on an inner side of the housing, and thereby divide the housing interior into three compartments 50, 52 and 54 respectively.

[0027] Figure 4 illustrates further details of the recessed formation 42C which extends a substantial portion of the width of the respective side, designated 56. A relatively large rectangular window 58 is formed in a base of the recessed formation. A rectangular cardboard insert 60, which has a centrally located relatively small rectangular window 62, is locatable in the recessed formation 42C.

[0028] Figures 9 to 11 illustrate successive stages in the manufacture of two coils of cable from a single length of cable 66. A large drum 68 of the cable 66 is mounted to suitable support structure 70. The cable 66 is passed over suitable pulleys and rollers 72 and 74 respectively and is wound in a first direction 76 about a first former 78. A predetermined length of cable, say 40 metres long, is wound onto the former 78 to form a single coil 80. A first end 82 of the cable is positioned inside an interior of the coil. Thereafter the coil is severed by means of a set of knives 84. The cable is then wound onto a second former 86 in a direction 88 which is opposite to the first direction 76. The cable is drawn from the single coil 80 for this purpose. In this way, as is shown in Figure 11, a first coil 90 is formed with a predetermined length of cable of, say, 30 metres and a second coil 92 is formed with a predetermined length of, say, 10 metres. The first coil has a second end 94 which is integrally connected to an end 96 of the second coil (referred to herein as the third end). A free end of the coil 92 designated 98, and referred to herein as the fourth end, is positioned inside an interior of the second coil.

[0029] As is shown in Figure 2 the first and second coils, which are coaxially aligned, are inserted into the compartments 50 and 54 respectively. The end portions 44 and 46, which act as dividers, have slits 99 through which parts of the cable section 100 between the coils (effectively the integrally joined ends 94 and 96 shown in Figure 11) can pass. The cable section 100 is then looped through the

window 58, as is shown in Figures 4 and 5. The first end 82 of the first coil is passed through an aperture 104 in the end 34 of the housing while the fourth end 98 of the second coil is passed through an aperture 106 in the end 36.

[0030] Referring particularly to Figures 7 and 8 a first connector 110 is crimped onto the cable section 100 without severing this cable i.e. the first and second coils are at all times integrally connected to each other. A label 112 is attached to the cable adjacent the first connector. A second connector 114 is attached to the fourth end of the cable. A detonator 116 of conventional design which is suited for daisy-chain connections is attached to the first end 82 of the cable.

[0031] The end 82 is looped, as is shown in Figures 2 and 8, and the detonator 116 is inserted into the compartment 50 so that it lies inside the hollow interior of the first coil 90. The fourth end 98 is folded over an external surface of the housing and is coupled with a press fit to the first connector 110. The cardboard insert 60 is then manipulated so that the connectors 110 and 114 pass through the window 62 together with the label 112. The insert is then pushed into the recessed formation 42C (see Figure 4) so that the connectors are contained within the recessed formation. Thereafter a preformed tubular sleeve 120, of rectangular cross-section, is placed over the housing to envelope the four larger sides. The sleeve is pre-printed with information which relates to the detonator and which is prescribed by regulation and legislation. The sleeve has slits 122 which define a rectangular section 124 which can be folded inwardly to nestle in the recessed formation 42B so that the sleeve is thereby kept in position on the housing.

[0032] When the detonator assembly is to be used it is transported to a blast site and allocated to a particular borehole 10. A tab 136 on the sleeve is pulled to tear

the sleeve free from the housing or, alternatively, the sleeve is torn only enough to expose the connector set. The connectors 110 and 114 are then detached from each other. The detonator 116 is extricated from the interior of the housing. Cable is drawn from the first coil 90 so that the detonator can be inserted to a predetermined depth inside the borehole. It is pointed out in this respect that the detonator 116 shown in Figure 7 corresponds to a detonator 14 shown in Figure 1. The length of cable between the detonator and the housing 32 is designated by the reference numeral 16 in Figure 1. A predetermined length of cable, corresponding to the length 20 shown in Figure 1, is drawn from the second coil. This enables the connector 114 to be connected to a corresponding first connector 110 at an adjacent borehole 14B, as is shown in Figure 1.

[0033] As each length of cable 16 and 20 is drawn from the housing the position of the first connector 110 is not materially altered. Excess cable not required for making connections between adjacent boreholes is left in the housing.

[0034] By mounting two coils inside the housing multiphase manufacturing steps are made possible. The housing, with its contents, can be moved or indexed through sequential automated manufacturing processes. The detonator and the connectors can be tested while secured within the packaging.

[0035] The outer sleeve is preferably pre-printed with deployment instructions and safety information as may be stipulated by local and international legislation. The sleeve is kept in position, relatively to the housing, by means of the folded portion 124 which engages with a corresponding recess 42B.

[0036] The recessed formations 42A and 42B facilitate handling of the housing for they provide convenient handgrips.

[0037] The detonator 116 is preferably stored as is shown in Figure 2, within the confines of the first coil 90. This, together with the partitioned packaging design, provides a substantial amount of separation of detonators which are in a plurality of detonator assemblies. The detonator can be removed from the housing without undue handling of the housing.

[0038] Figures 12 to 14 illustrate a detonator assembly 30A, according to a variation of the invention, which bears substantial similarities to the detonator assembly 30. Consequently, where relevant, like reference numerals are used to designate like components.

[0039] First and second coaxially aligned coils 90 and 92 respectively, which are slightly spaced from each other, are formed using any suitable technique. Each cable coil has a plurality of windings 150, 152 around a corresponding hollow core 90A, 92A, and has a circular cylindrical shape. The cable coils are linked by a cable section 100 to which a connector 110 is crimped. An end 82 of the first coil is connected to a detonator 116 which is positioned inside the hollow core 90A of the first coil. An end 98 of the second coil, accessible from the hollow core 92A of the second coil, is connected to a connector 114 which can be mated to the connector 110.

[0040] The coils 90 and 92 are separately wrapped in a suitable sheet material, e.g. a cling-wrap plastic material 160 and 162, and the coils are then held in a fixed relationship to each other by means of a confinement structure which comprises a

shrink wrapping 164 which has openings 166 and 168 at opposed ends of the assembly through which the detonator 106 and the connectors 110 and 114 can respectively be accessed.

[0041] Figure 14 is similar to Figure 1 and depicts a blasting arrangement which is established through the use of a plurality of the detonator assemblies 30A. For the sake of convenience reference numerals which are the same as those in Figure 1 are used to designate like components.

[0042] The detonator assembly 30A is used in substantially the same way as the detonator assembly 30. The wrapping 164 is cheaper than the housing 32 and, apart from the access openings 166 and 168, is waterproof.

[0043] In the preceding description the cable coils 90 and 92 are linked by the integral cable section 100. Although this is a preferred form of construction it is not essential for the respective end portions of the cable coils could be interconnected through the use of a suitable connector 110, which is also designed to engage with a connector 114.

[0044] The detonator assembly provides a means of connection between detonators inside the same blast hole or in sequential blast holes, by permitting sufficient cable to be withdrawn from the housing. Unused cable remains securely within the packaging and the likelihood of cable knots or damage occurring is reduced.

[0045] The invention has been described with reference to the use of a single detonator in each borehole. Similar techniques can be employed to make connections between two or more detonators in a single borehole, if required.